Introduction- Udayashankar Ganapathy

- **Professional Mechanical Engineer with Honours.**
- **MBA from University of Alberta**
- **In Oil and Gas industry for more than 30 years.**
- **Certified Maintenance and Reliability Professiona**
- **Member of Emirates Institute of Engineers, Indian Institution of , Indo-Canada Engineers, etc.**
- **Presented papers in Oil and Gas forums & published articles.**
- **Work for Suncor Energy, Canada in Upgrading as Senior Reliability Engineer in Hydrotreaters.**
- **Family: Totally 5 -Spouse Chithra, Daughter Akshaya, Sons: Anirudh & Sai.**

How important are the Protection systems & valve design that can contribute to the Equipment Integrity on Reciprocating Compressors

by

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Agenda

System Description

Analysis

Root cause

Corrective measures

Conclusions and Lessons learned

How Does Corrective / Preventative Action

(s) resolved the Issue

Take Away

System Description

Hydrogen product compressors, Machines A & B,
•increases Pressure of the hydrogen gas from 230 psig to 1646 psig for the three Hydrotreaters.

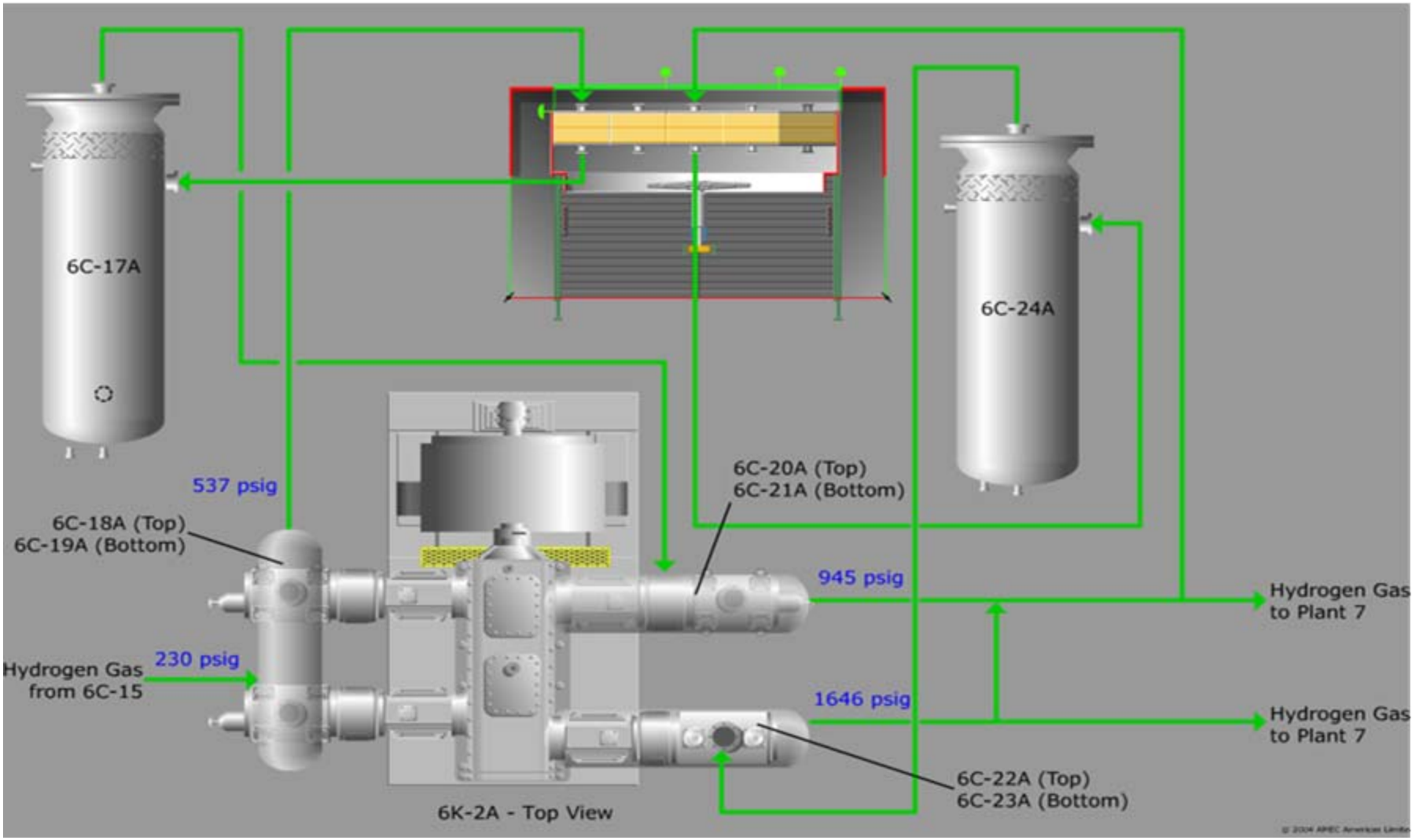
•Four cylinder, 3 stage reciprocating compressors.- Driven by 4000HP Sync Motor.

•36 valves in total. III stage has 2 Suction & 2 Discharge valves & has Intercoolers between stages

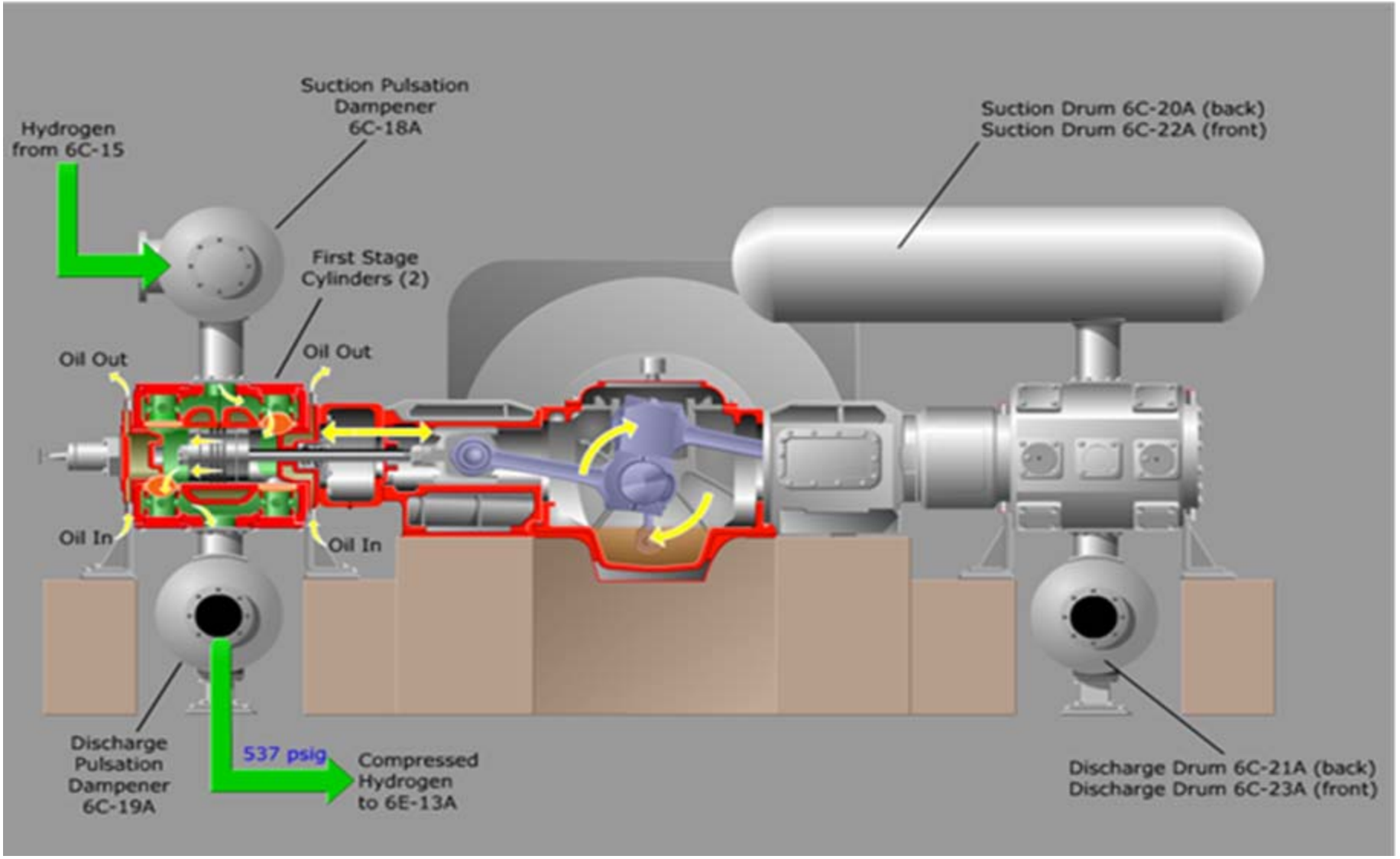
•2 x 50%- No spare. If anyone is offline we cannot operate Hydrotreaters at full charge rates.

•Has 3 lubrication & cooling systems –for Compressor cylinders, Crankcases & Running gear

System Description



System Description



Sequence of Events

At 11:00 hrs. ,May 4th, 2011, the temperature of III stage discharge valves on M/c A & B as well was trending up when put online.

May 5th 02:55 hrs., Machine B tripped on low lube oil pressure due to plugging of Lube Filters-filters plugged mainly with Crosshead shoe metal.

This resulted in low operating pressure & inadequate hydrogen supply to Hydrotreaters. One plant was taken offline

Upon opening third stage head end discharge valve was passing. Damage to Third stage cross head shoe, pin, and bushing were also observed.

Crosshead Damage

Seized Crosshead pin

Crosshead shoe damage & Source of Aluminum

Crosshead Pin damage

Damaged III Stage Valve & Valve Spring

Analysis

Inadequate procedure : Low suction pressure trip disabled

Insufficient design of ring valves-III stage discharge

Higher stiction factor compromises the performance

Increase in the number hours of break-in lube oil injection

Process pressure fluctuations in the system

Quick changes in valve positions (all are manual valves)

Inadequate unloader system

Inadequate logic design-Aux pump not online

Analysis (Metallurgical)

The outside of the pin showed metal transfer (predominantly on one side)

Heat tint (i.e. bluing), suggested the metal exceeded 640 °F.

The bushings exhibited internal & external surfaces damage. Aluminum overlay on the inside surface of the bushings was also damaged.

Damage possibly due to high friction & often a result of insufficient lubrication.

Circumferential damage indicated that the bushings had spun / rotated in the crosshead housing.

Root Cause

Combination of events led to lack of rod reversal on third stage caused III stage crosshead to fail

Discharge valve failure was due to a soft spring.

Conclusions & Lessons Learned

The valve design should consider stiction adequately

Low lube oil pressure tripped the compressor due to:
- lack of lube oil from the auxiliary lube oil pump,
-lack of rod reversal

Caution & due diligence is required when by-passing trips
We should be vigilant on the status of alarms.

Safe operating windows for machines should be well understood.

Valve simulation & motion studies from Valve vendor should be reviewed well in advance

Take Away

It is often complex to understand the issues with recip. machines due to too many components & variables.

Consider good condition monitoring systems to forewarn impending failures- for e.g. Crosshead condition monitoring.

Valve design is highly specialized & still we cannot possibly predict what might happen to valves under varying conditions